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August 18, 2004

RECEIVED

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 Office of the Secretary

BY HAND DELIVERY
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Re: SafeView, Inc., Request for Waiver of Sections 15.31 and 15.35 of the Commission's Rules

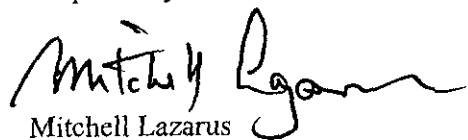
Dear Ms. Dortch:

On behalf of SafeView, Inc. and pursuant to Section 1.3 of the Commission's Rules, I enclose for filing with the Commission the original and four copies of a Request for Waiver directed to the Chief, Office of Engineering and Technology. This replaces the document submitted on August 13 and withdrawn on August 16.

For electronically-generated copies of this document in PDF format, kindly contact me at
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Please do not hesitate to let me know if there are any questions.

Respectfully submitted,


 Mitchell Lazarus
 Counsel for SafeView, Inc.

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Before the
Federal Communications Commission
Washington DC 20554

In the Matter of

SafeView, Inc., Request for Waiver
of Sections 15.31 and 15.35 of the
Commission's Rules to Permit the
Deployment of Security Screening Portal
Devices that Operate in the 24.25-30 GHz
Range

File No. _____

To: Chief, Office of Engineering and Technology

REQUEST FOR WAIVER

August 18, 2004

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To: Chief, Office of Engineering and Technology

REQUEST FOR WAIVER

Pursuant to Section 1.3 of the Commission's Rules, SafeView, Inc. submits this request for waiver of Sections 15.31(c) and 15.35(b).

A. Summary

Anyone who has flown lately, or visited a Government building, understands why the Nation needs better security procedures. The methods now in use depend on a haphazard combination of walk-through metal detectors, hand wandling, luggage x-rays, and hands-on "pat down" searches. These have serious drawbacks. They are slow and intrusive, as evidenced by long security lines at every major airport and high levels of passenger frustration. And they do not work well. GAO reports that weapons get through in fully a quarter of covert tests at major airports. Present methods are especially poor at detecting non-metallic threats, such as weapons made of plastic or ceramics and many types of explosives. These shortcomings are a grave concern, especially amid current tensions.

SafeView, supporting the interests of the Department of Energy and the Transportation Security Administration, has developed a technology that directly addresses these problems. A

person being screened, such as an airline passenger, steps into a chamber, waits for two seconds, and steps out again. Seconds later, security officers have a three-dimensional image that allows them to clearly identify any weapons or contraband on the subject's person -- including non-metallic objects carried inside or under the clothing. The law-abiding traveler goes on his way, freeing the officers to attend to those few who may present a genuine threat. Delays are greatly reduced; allegations of "profiling" and "groping" drop; and, most important, security procedures become far more effective.

The SafeView device operates by measuring the reflections of near-millimeter radio waves at very low levels. The device contains two vertical masts, each carrying 192 transmit antenna elements arranged vertically. While the masts rotate around the subject over a 2 second interval, each antenna element in turn sweeps quickly from 24.25 through 30 GHz, taking 6 microseconds per sweep. The device complies with the Commission's RF exposure safety rules by a very wide margin.

SafeView seeks to certify the device under Section 15.209. To accomplish that, we request waivers of two technical rules. One is Section 15.31(c), which requires emissions measurements with the frequency sweep stopped. The SafeView device's fast sweep distributes a very low level of energy across a wide range of spectrum, thus rendering it harmless to any receiver. Measurements with the sweep stopped, with all of the energy concentrated at a single frequency, greatly overstate the interference potential. Tests with the sweep running, as we request, better reflect the absence of interference potential, and put the average emissions under the limit. Second, Section 15.35(b) limits peak emissions to no more than 20 dB above maximum average emissions. Tests with the sweep running do not reduce the peak

measurements, as the instrumentation "holds" the same peak value whether the sweep is running or not. Because the peak emissions exceed the limit, SafeView also requests a waiver of Section 15.35(b).

Sections 15.31(c) and 15.35(b) serve similar purposes: they both limit interference to receivers having a fast transient response. The SafeView device limits such interference by other means. First, the size and expense of these units will drastically limit the number deployed. Second, all devices manufactured under the waiver will be installed indoors, where high building attenuation will protect any outdoor victim receivers; and there are none indoors. Third, the duty cycle of the SafeView device is extremely low. A given victim receiver with a 10 MHz passband would see the SafeView emissions only for 9.1 nanoseconds at a time, with a duty cycle of -83 dB. That is, if a receiver can detect the SafeView signal at all, it will see it only 1/200,000,000 of the time. Finally, the devices will be permanently installed at a small number of fixed, known locations.

SafeView proposes two waiver conditions. First, we offer to maintain a database of installations, to help identify the source of any interference (or, more likely, to rule out SafeView equipment as the cause), and will share this information with the Commission and NTIA. Second, we can limit installations to 100 units during the first year under the waiver, and to 200 units during the second year.

We show below that this request fits squarely within the waiver criteria established by the U.S. Court of Appeals in *WAIT Radio v. FCC*. We also explain (if an explanation is needed) why this request has no bearing on the regulation of frequency-hopping ultra-wideband devices.

In short, the SafeView device provides an important and needed advance in protecting the American public. It presents no realistic possibility of interference to any spectrum user. We urge the Commission to permit the deployment of this device at the earliest possible date.

About SafeView, Inc. SafeView develops and manufactures equipment for security screening at entry points where large numbers of people gather, such as airports, commercial buildings, schools, and entertainment venues. The company uses a new technology that employs near-millimeter waves to generate 3D holographic images of people passing through a security portal. The device greatly assists in the reliable detection not only of metal threats, but more importantly today, of plastic and ceramic objects as well, including explosives and non-metallic guns and knives.

SafeView was founded in late 2001 by the non-profit Battelle Trust, which manages Pacific Northwest National Lab (PNNL), and two investors. The company's charter is to commercialize active radio-frequency holography originally developed by the U.S. Government for security screening at PNNL. The primary funders for that work were the Federal Aviation Administration (now the Transportation Security Administration) and the Department of Energy. PNNL contributed an exclusive license to SafeView for its intellectual property, including four milestone granted patents and several additional filings, and rights of use including all future intellectual property in this area.

SafeView's leadership team and early engineering staff joined the company in October of 2002 and began the design effort with over \$1M of seed financing. Venture capital firms provided another \$7M in June 2003 to complete the development of systems intended for use in airports, government buildings, prisons, military installations, and perhaps eventually

commercial buildings. The company has recently completed its second round of financing of \$16M and is presently in field test around the world with its system design. SafeView itself has now filed ten patent applications and has developed approximately 30 additional disclosures.

B. SafeView Technology

Governments worldwide have long sought methods for reliably locating unauthorized weapons and other contraband. Undetected, these have the potential to threaten not only citizens' health and safety, but also reliability of transportation, communications, energy distribution, and economic interests generally. Recent terrorist activity has emphasized the urgency of these concerns.

There is an especially pressing need for improved security at the "entry portals" that separate the public at large from persons inside a controlled area such as an airport, stadium, or government building. Existing methods rely largely on metal detectors and hand searches. But these are widely understood to be inadequate. They create large numbers of false positives, which drive up cost, delay, and public dissatisfaction. They miss many metallic weapons; are inherently poor at finding non-metallic weapons and contraband; create long queue times; and produce ancillary negatives such as allegations of "groping" during hand searches. Moreover, it is rarely practical to hand-search every person passing through a portal. The need to identify individuals subject to hand searches both raises complaints about "profiling" and opens a route for non-metallic objects to escape detection entirely.

The SafeView device scans the subject (typically a person) to produce a three-dimensional image of near-photographic quality that shows both metallic and non-metallic objects, including plastic or ceramic objects hidden in or under the subject's clothing.

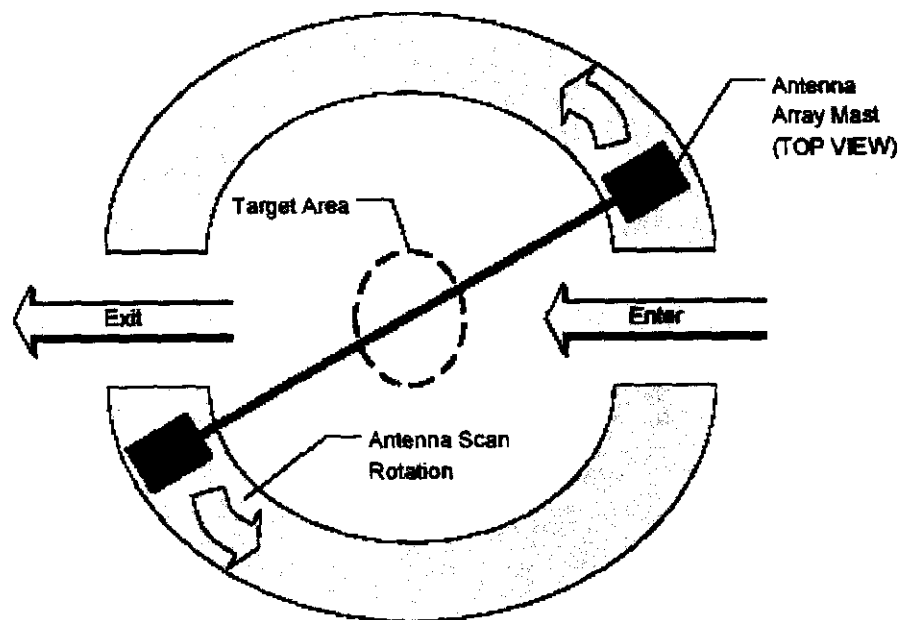


Figure 1. A diagram of the top view of the imaging system is shown. Two antenna masts rotate in unison about a stationary subject located in the target area. The masts are enclosed in a protective 'shelf' to avoid any interaction between the subject and moving parts of the system.

The subject enters the SafeView system and stands in the target area. See Figure 1. Two vertical antenna masts each carry 192 transmit antenna elements. The two masts each revolve 110 degrees around the subject in less than two seconds.¹ See Figure 2. While the masts are in motion, a transmitter sequentially feeds the antenna elements. Only one element on each mast transmits at a time. Each element in turn sweeps between 24.25 and 30 GHz at a rate of 1.1 MHz/ns, so that each sweep takes 5.5 μ s. There is a pause of 2.6 μ s between sweeps. Each antenna element carries out the sweep twice, and then the next element in sequence does the

¹ The system configuration can allow for scan angles greater than 110 degrees. For purposes of the technical discussion, 110 degrees represents the worst case with respect to analysis of potential RF interference.

same. The full cycle over all elements on both masts takes 3.1 ms. There is a pause for 5.5 ms, then the cycle repeats, a total of 210 times as the masts rotate.

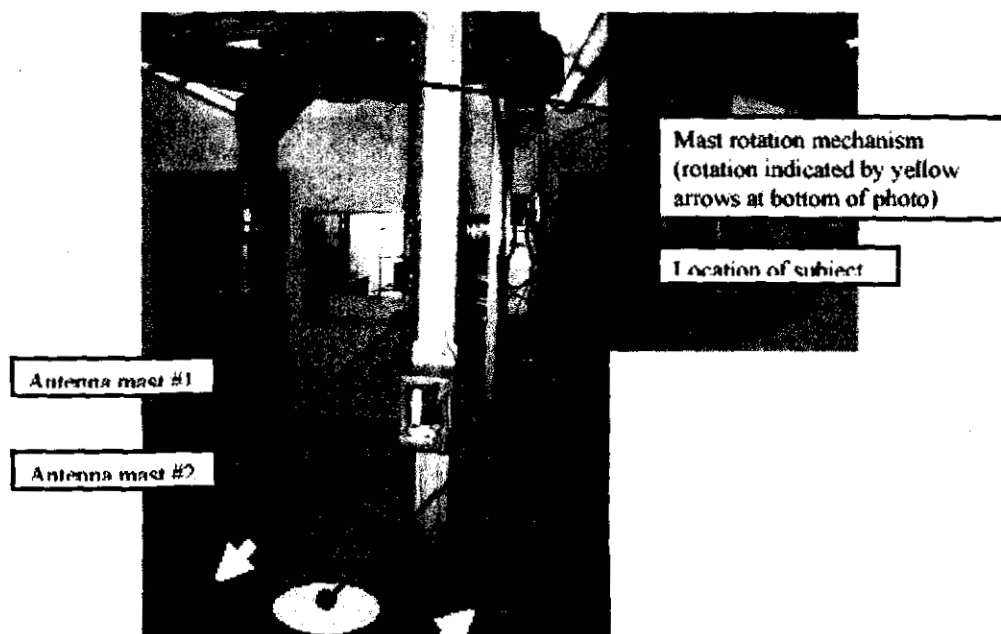


Figure 2. Imaging system indicating antenna masts and rotation mechanism (above left, shown without housing or protective covers).

Receivers collect reflected data from various angles. Within another few seconds, this large amount of data is processed into a holographic image of the subject, including any hidden objects. See Figure 3. Features include automatic object identification, privacy algorithms, remote viewing, and data logging. There are no further transmissions until the next subject enters the system. The typical time interval between scanning successive subjects is at least 8 seconds.

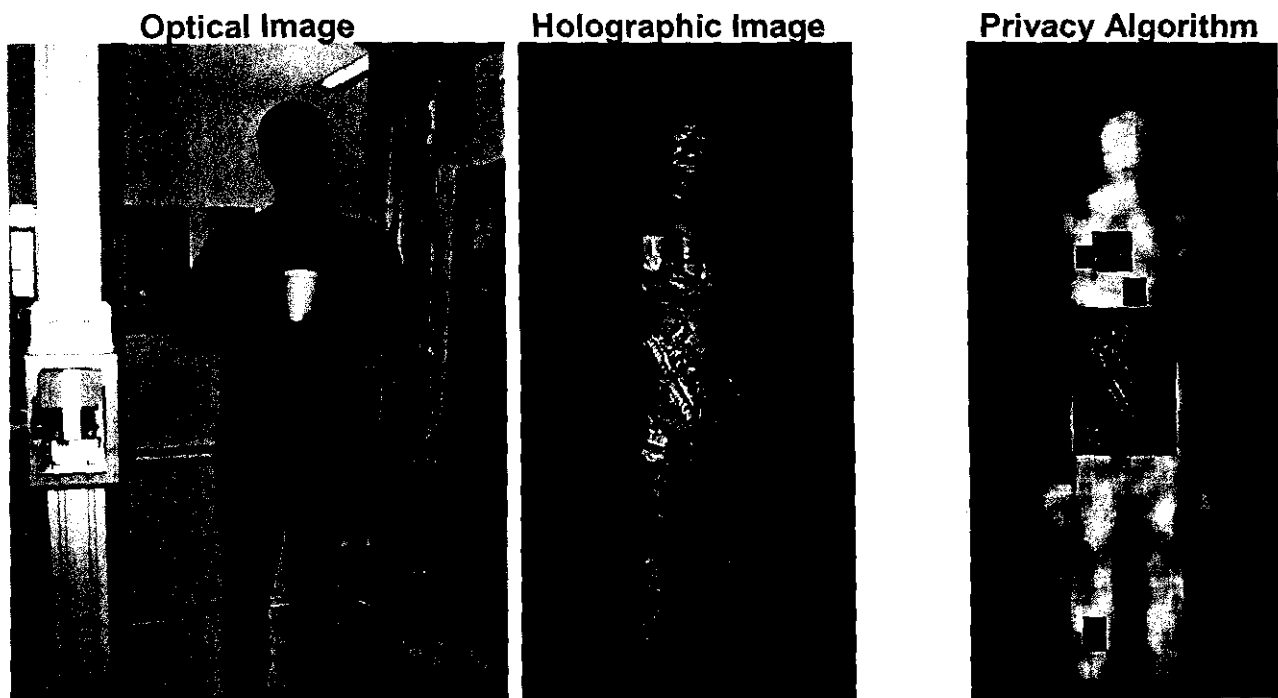


Figure 3 From left to right: optical image; SafeView Image showing various weapons and contraband (note plastic pistol and liquid inside cup); SafeView image with automatic privacy algorithm enabled and object detection windows activated.

The system is intended for operation by trained security personnel. Critical RF parameters that could affect FCC compliance (transmit frequencies, power, system timing, etc.) are factory set and are not accessible to operators in the field.

Public interest. The public interest in this equipment is exceedingly high. SafeView offers a fast, reliable method to aid the imaging of hidden weapons, explosives, and contraband of many kinds that would otherwise require intrusive manual searches, or be missed entirely. Once in widespread use, the device will greatly elevate confidence in public safety.

Anyone who flies nowadays has experienced frustrating delays while security personnel pass travelers through metal detectors, divert and wand those who set off the alarm, and identify selected individuals to take off outer clothing, empty their pockets, and endure a manual pat-

down. It is a slow process, and it yields unreliable results at best. These procedures are especially hard on elderly and handicapped people, those who do not speak English, and parents traveling with small children. And studies show that a distressing quantity of weapons still get through. According to Senate testimony by General Accounting Office inspector Gerald L. Dillingham, "Recent TSA testing found that screeners at 32 of the nation's largest airports failed to detect fake weapons (guns, dynamite or bombs) *in almost a quarter of the undercover tests* at screening checkpoints."²

The SafeView device solves these problems. It is fast, physically non-invasive, and extremely effective. We respectfully suggest that the very high public interest justifies the requested waiver.

C. Requested Waivers

SafeView requests waivers of Sections 15.31(c) and 15.35(b) of the Commission's Rules.

Section 15.31(c) provides:

For swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.³

SafeView requests a waiver of this provision to permit compliance testing with the frequency sweep operating.

Section 15.35(b) provides, in part:

When average radiated emission measurements are specified in this part, including emission measurements below 1000 MHz, there also is a limit

² *Report: Undercover agents slipped through fake bomb, knife*, USA Today (Jan. 21, 2003) (emphasis added), <http://www.usatoday.com/travel/news/2003/2003-01-21-bdl-security.htm>

³ 47 C.F.R. Sec. 15.31(c).

on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules⁴

SafeView also requests a waiver of this provision to permit higher peak emissions.

Both requests are subject to appropriate safeguards. Below, we set out why the waivers are necessary, and why they will be harmless to other users of the spectrum.

Necessity. Peak emissions of the SafeView device are 21dB above the limit in Section 15.35(b).⁵ "Average" emissions, if measured with the sweep stopped under Section 15.31(c), would no longer be average, but would be artificially forced to the same value as the peak emissions.

At the current state of the technology, turning down the power to comply with the limits as measured under these rules would render the device inoperative. Operation at reduced power may prove feasible over the long term, and that goal is prominent on SafeView's technology roadmap. In the short term, however, without regulatory relief, the only other solution would be to install metal shielding completely around the device. That would seriously compromise performance. The device operates by processing low-power radio-frequency energy reflected from a person's body. A shielded structure would necessarily place coherent close-range reflected and multi-path energy into the device's receivers at levels exceeding the desired signal. That would degrade image quality and impair the ability of the device to detect objects. The only

⁴ 47 C.F.R. Sec. 15.35(b).

⁵ Section 15.209(a) limits transmitted average power above 960 MHz to -41 dBm EIRP. Section 15.35(b) additionally restricts peak power to 20 dB above maximum average power, or -21 dBm EIRP. To resolve its targets adequately, the SafeView system must transmit 100µW peak into an antenna with 10 dB gain, for a peak power of about 0 dBm EIRP, or 21 dB higher than the limit.

way to mitigate these unwanted reflections is essentially to construct an anechoic chamber by lining the shield with absorbing material, with the result of increasing the size and cost of the device to the point where installations become physically and economically unworkable. In short, we see no practical technical solution that eliminates the need for a waiver.

D. Grounds for Waiver

A grant of the requested waiver will not cause harmful interference to any victim receiver. (Appendix B lists U.S. uses of the frequencies at issue.) Each of the grounds listed here would suffice by itself to prevent interference. Their combination gives the Commission added assurance that interference will not occur.

Low geographic density. These devices are intended primarily for use in transportation terminals, government buildings, prisons, and border crossings. Moreover, the devices are expensive -- we project initial pricing to exceed \$100,000 per unit, installed -- and their operation requires trained personnel. The combination of limited applicability and high cost will keep the number of installed units very low, compared to most commercial products, and extremely low compared to consumer devices.

Indoor operation. All devices produced under this waiver will be installed for indoor use. Building attenuation alone at 24-30 GHz should be enough to bring emissions close to compliance. (There are no indoor victim receivers. See Appendix B.)

Very low duty cycle. The duty cycle at any frequency, in any direction, is extremely small. A given receiver having a bandwidth of 10 MHz sees the SafeView device with a duty cycle of only -83 dB. In other words, if it can detect the SafeView signal at all, the receiver sees that signal only 1/200,000,000 of the time. Several factors contribute to this result:

1. **FAST SCAN.** The scan rate of 1.1 MHz/ns places an output signal within the passband of a nominal 10 MHz bandwidth receiver for only 9.1 ns at a time. The scan is then absent from the receiver passband for fully 8.08 μ s. Thus, it is present in the passband only 0.1% of the time.
2. **FAST-MOVING DIRECTIONAL ANTENNA.** Each antenna element has a gain of 10 dB and operates only while rotating at 57 degrees/second. During rotation, the antenna masts transmit at discrete angles for 3.1 ms at a time, and are turned off for 5.5 ms while the mast repositions to the next angle. A victim receiver is within the 3 dB beamwidth of an antenna element only for a short time, and during the vast majority of that time the emissions are out-of-band to any given receiver.
3. **SHORT TRANSMIT TIMES.** The device transmits for a total of 2 seconds while scanning a subject, and is then silent for at least 8 seconds while the subject leaves the device and another enters. (This time interval is also used for computation of the image and its inspection by security personnel.) Thus, even at maximum throughput, the device is active only 20% of the time.

Appendix A shows a detailed calculation of the overall duty cycle, which is -83 dB.

Fixed, known locations. These are large, heavy devices that are permanently installed.

The location of each unit is easily recorded and accessed.

E. Waiver Conditions

SafeView proposes two conditions to help limit interference and to identify the source if it occurs. We emphasize that neither of these measures is necessary, but we will accept either or both if doing so facilitates a grant of the waiver.

1. ***Installation database.*** If the Commission so requests, SafeView will create and maintain a database of its installations, including the identity of the customer, type of location (such as airport or Government building), and street address and/or coordinates.

SafeView will make the database available on request to the Commission or to NTIA.⁶ In the

⁶ In connection with any such disclosure, SafeView may request confidentiality under the Freedom of Information Act.

extremely unlikely event that interference were to occur, this data would enable prompt identification of the offending device -- or, more likely, rule out the SafeView equipment as the source.

2. ***Quantitative limit on installations.*** SafeView will limit the number of devices installed under this waiver to 100 units during the first twelve months following the grant, and to 200 units during the second twelve months.

F. Ultra-Wideband Issues Distinguished

Notwithstanding superficial similarities, SafeView's request to permit emissions measurements to be made with the frequency sweep stopped, by waiver of Section 15.31(c), is unrelated to two ultra-wideband issues presently before the Commission. A grant of this request will not prejudice the Commission's options in those other matters.

1. ***Ultra-Wideband Frequency Hopping.*** Two companies have asked the Commission to rule that frequency-hopping ultra-wideband communications systems must be tested for compliance with the hopping stopped.⁷ They argue that testing with the frequency hopping active would raise the allowable emissions at any affected frequency and threaten harmful interference to other spectrum users.

That request is irrelevant to this one. First, and most important, the issues raised in the XtremeSpectrum/Motorola request are unique to the ultra-wideband regulatory environment, particularly to operation in the restricted bands that are closed to Section 15.209 devices.⁸

⁷ Request for Declaratory Ruling of XtremeSpectrum, Inc. and Motorola (filed July 28, 2003). The Commission has not put this request on public notice. Counsel for SafeView is a signatory to the request.

⁸ 47 C.F.R. Sec. 15.205(a).

SafeView does not seek to operate as an ultra-wideband device or in any restricted bands. Second, the testing scheme opposed in the frequency-hopping request would trade off higher emissions for a lower duty cycle, dB for dB. Here, the extraordinarily low duty cycle of -83 dB is offset by a much smaller increase in emissions. Third, the frequency-hopping request covers 3.1-10.6 GHz, a range that serves very sensitive broadband receivers, including the ubiquitous C-band satellite downlink earth stations at 3.7-4.2 GHz. The frequency range at issue here, 24.25-30 GHz, has no comparable receivers. (See Appendix B.) Finally, the frequency-hopping request addresses mobile consumer devices intended to be deployed in very large quantities, while the devices at issue here will be operated only indoors, in small numbers, and at fixed locations.

In short, the Commission can rule favorably on the present request without affecting the ultimate outcome of the XtremeSpectrum/Motorola matter.

2. Ultra-Wideband Vehicle Radars. The Commission is presently considering whether to allow frequency-hopping vehicle radars at 22-29 GHz to qualify for ultra-wideband status by averaging the occupied bandwidth over a 10 ms period.⁹ That proceeding likewise has nothing to do with this request. SafeView does not seek certification as an ultra-wideband device. Moreover, the vehicle radars are mobile consumer devices that will be deployed in large numbers, and which seek to operate in two restricted bands.¹⁰ For each of these reasons, a decision on the SafeView device has no bearing on the vehicle radars, and vice versa.

⁹ *Ultra-Wideband Transmission Systems*, 18 FCC Rcd 3857 at paras. 156-161 (2003) (Memorandum Opinion and Order and Further Notice of Proposed Rule Making).

¹⁰ *I.e.*, 22.01-23.12 and 23.6-24.0 GHz. See 47 C.F.R. Sec. 15.205(a).

In short, there is no rational link between either of these ultra-wideband issues and the present request.

G. RF Safety Compliance Issues

The SafeView device complies with the Commission's RF safety rules by several orders of magnitude.

Ordinarily the subject stands 40 cm from the antenna elements. In the worst case, with the subject not only off center but leaning against the interior protective covering, the subject would be 2.5 cm from the antenna elements. The power density at that distance is $13 \mu\text{W}/\text{cm}^2$. This is far below the Commission's "general population/uncontrolled" limit of $1 \text{ mW}/\text{cm}^2$.¹¹ Moreover, the stated density is an instantaneous value. Averaged over 30 minutes,¹² it becomes insignificant, on the order of $13 \text{ nW}/\text{cm}^2$ -- five orders of magnitude below the limit.

H. Waiver Standard

The Commission assesses waiver requests according to the principles established in *WAIT Radio v. FCC*.¹³ In that case, as here, the applicant sought to operate in contravention of

¹¹ 47 C.F.R. Sec. 1.1310 (table). Calculation: Power density = power * (antenna gain) / (surface of sphere radius 2.5 cm) = $100 \mu\text{W} * 10 \text{ dBi} / (4 * \pi * (2.5 \text{ cm})^2) = 13 \mu\text{W}/\text{cm}^2$. See *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, OET Bulletin 65, Office of Engineering & Technology, Edition 97-01 (August 1997).

¹² 47 C.F.R. Sec. 1.1310 (table).

¹³ 418 F.2d 1153 (D.C. Cir. 1969). E.g., 2002 Biennial Regulatory Review, 18 FCC Rcd 13620 at para. 85 n.130 (2003) (citing *WAIT Radio* as "setting out criteria for waivers of Commission rules.")

the rules while explaining how it would accomplish the purpose of the rules by other means.¹⁴

The court required the Commission to consider the request:

[A] general rule, deemed valid because its overall objectives are in the public interest, may not be in the "public interest" if extended to an applicant who proposes a new service that will not undermine the policy, served by the rule, that has been adjudged in the public interest.¹⁵

The plain meaning of the passage is clear: Waiver is appropriate where the applicant maintains the public interest in the underlying rule. SafeView does so here. It will fully achieve the purpose of Sections 15.31(c) and 15.35(b) -- avoiding transient interference -- through low duty cycle, low geographic density, and indoor operation, as detailed above. Moreover, SafeView will further the public interest in important respects, by advancing public safety while speeding lines through airports and other critical threshold points. The requested waiver thus fits easily within the boundaries drawn by *WAIT Radio*.

Moreover, the Court of Appeals emphasized the importance of waiver procedures as part of the regulatory scheme:

The agency's discretion to proceed in difficult areas through general rules is intimately linked to the existence of a safety valve procedure for consideration of an application for exemption based on special circumstances.¹⁶

¹⁴ WAIT Radio operated an AM broadcast station. It was limited to daylight hours so as to afford protection to "white areas" that had no local service, and that relied on nighttime skywave propagation from another station. WAIT Radio proposed to transmit at night using a directional antenna that would keep its signal out of the white areas. *WAIT Radio v. FCC*, 418 F.2d at 1154-55.

¹⁵ *WAIT Radio v. FCC*, 418 F.2d at 1157.

¹⁶ *Id.*

Thus, it said, "allegations such as those made by petitioners, stated with clarity and accompanied by supporting data . . . must be given a "hard look.""¹⁷

Here, too, the SafeView request fully qualifies. The "safety valve" of the waiver procedure is needed to make available an important tool for maintaining security where people are most vulnerable, whether in an aircraft at 35,000 feet or crowded together in a stadium or school. The requested waiver is in the public interest, not only in terms of benefits to the public, but also in the absence of any possible increase in harmful interference. The request is entitled not only to a "hard look" mandated in *WAIT Radio*, but to a grant of the waiver.

CONCLUSION

The SafeView device offers a greatly needed tool for promoting public safety. Two major obstacles to deployment are the test procedure in Section 15.31(c), which requires compliance measurements with the sweep running, and the peak emissions limit in Section 15.35(b). We showed in detail that a waiver of those sections will not result in interference to other spectrum users, by virtue of a combination of low deployment density, indoor operation, and extraordinarily low duty cycle. In addition, the installation of relatively few devices at fixed, known locations makes it easy to trace interference, if it were to occur. SafeView offers to limit the number installed and to track their locations. The requested waiver is plainly in the public interest, and plainly meets the standard of *WAIT Radio v. FCC*.

¹⁷ *WAIT Radio v. FCC*, 418 F.2d at 1157 (citation footnote omitted).

In the interest of public safety, and with no realistic possibility of harm, we urge the Commission to grant the waiver promptly.

Respectfully submitted,

/s/

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Counsel for SafeView, Inc.

August 18, 2004

Appendix A

Example of duty cycles associated with the transmission of RF signals at a victim receiver.

System Configuration

Before calculating the duty cycles affecting transmission at a victim receiver, basic information on the imaging system configuration is presented. The system consists of 2 antenna arrays that are vertically oriented and 180 degrees opposed (see Figure A1). The antenna arrays (or "masts") scan a path of 110 degrees, in a cylindrical motion, about the desired target (or "subject") to be imaged. The diameter of the scanned cylinder is approximately 1.3 meters. An antenna mast consists of 192 transmit and receive elements, vertically polarized.

Duty Cycle Calculation

In order to calculate the effective duty cycle of energy directed to a victim receiver, the following assumptions are made:

1. The channel bandwidth of the victim receiver is 10 MHz, which is believed to be representative of systems deployed in the 24 GHz to 30 GHz frequency range (see Appendix B)
2. The victim receiver has an antenna which is oriented directly at the SafeView system, and one antenna mast of the SafeView system is oriented directly at the victim receiver when the mast reaches the mid-point of its scan angle. This represents the worst case scenario of many possible orientations, and ignores the fact that the antenna is pointing in different directions during the scan operation (i.e. transmitted energy in a given direction will be less in practice).
3. The duty cycle is referenced to an integration time period of 10 seconds, as this relates to the actual performance of one scan operation. This represents the worst case scenario, as it assumes maximum throughput and continuous operation of the unit.

The total duty cycle is a composite of various duty cycles associates with the timing and operation of the unit. A basic timing diagram is illustrated in Figure A2. The duty cycle is derived by combining the following elements:

1. The amount of time a signal is present in the victim receiver channel, relative to the sweep rate and period.
2. The ratio of the horizontal motion transmit "active" time to the period of horizontal scanning.
3. The ratio of the scan "active" time to the scan operation period.

In the imaging system, the scan is active for 1.8 seconds during a period of 10 seconds. The remainder of the time, the unit is processing information and the transmitter is inactive. The duty cycle is calculated from the ration of 1.8s to 10s.

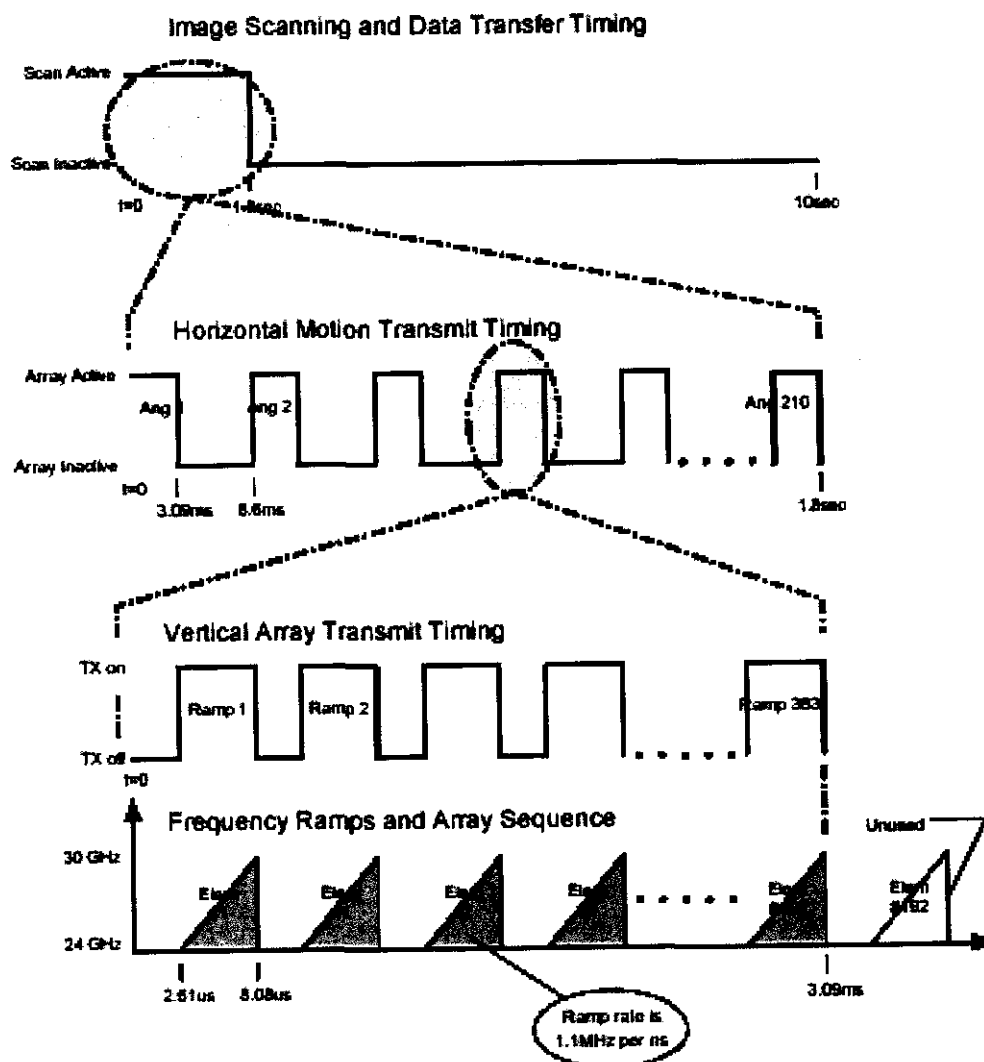
During the 1.8 second scan, the unit is in motion. While in motion, the antenna mast is active for 3.09ms during a period of 8.6ms. The duty cycle is calculated from the ratio of 3.09ms to 8.6ms.

While the antenna mast is active, the transmitter is on for a duration of 5.47us out of a period of 8.08us. Each antenna element transmits for two pulses, and then the signal is switched to an adjacent element. The frequency ramp rate is given by the frequency range divided by the duration, or $6\text{ GHz}/5.47\mu\text{s} = 1.1\text{MHz per nanosecond}$. With respect to time averaging, this equates to transmit energy being present in a given 1 MHz bandwidth for 909ps, or in a 10 MHz bandwidth for 9.09ns. In this example, the duty cycle is calculated from the ratio of 9.09ps to the period of 8.08us.

$$\text{Duty cycle (dB)} = 20 \cdot \log(1.8\text{s}/10\text{s}) + 20 \cdot \log(3.09\text{ms}/8.6\text{ms}) + 20 \cdot \log(9.09\text{ns}/8.08\mu\text{s})$$

$$\text{Duty cycle (dB)} = -14.9 - 8.9 - 59.0$$

$$\text{Duty cycle (dB)} = -82.8$$



Appendix B

List of potential victim receivers in the 24 GHz to 30 GHz frequency bands

Receivers

Frequency (GHz)	U.S. Usage	Receiver Characteristics	Interference Issues
24-24.05	amateur satellite (downlink)	300 kHz digital 250 kHz analog (extremely sensitive)	This band is avoided.
24.05-24.25	amateur private land mobile earth exploration satellite	amateur: (little used) PLMR: (bandwidth not specified) ESS: (receivers in orbit)	This band is avoided.
24.25-24.45	fixed microwave	fixed microwave: bandwidth 40 MHz max satellite: (receivers in orbit)	OK -- In-orbit satellites cannot receive interference; fixed microwave is extremely unlikely to receive interference; aviation radar allocation is unused.
24.45-24.75	satellite (uplink)		
24.75-25.05	satellite (uplink); aviation radar		
25.05-25.25	satellite (uplink); fixed microwave		
25.25-27.5	Gov't satellite (uplink) earth exploration satellite	satellite: (receivers in orbit)	OK -- In-orbit satellites cannot receive interference; earth exploration satellites are extremely unlikely to receive interference.
27.5-29.5	satellite (uplink); fixed microwave	fixed microwave: bandwidth 40 MHz max satellite: (receivers in orbit)	OK -- In-orbit satellites cannot receive interference; fixed microwave is extremely unlikely to receive interference.
29.5-30	satellite (uplink)		